

WHAT IS CLAIMED IS:

1. A multi-layer diffraction type polarizer comprising a lamination of at least two polarizing diffraction gratings each comprising a birefringent material, wherein
5 the diffraction gratings each straightly transmits incident light having a first polarization direction without functioning as a polarizer, and diffracts incident light having a second polarization direction perpendicular to the first polarization direction by
10 functioning as a polarizer.
2. The multi-layer diffraction type polarizer according to Claim 1, wherein each of the polarizing diffraction gratings comprises a birefringent material layer formed on a transparent substrate and having an ordinary
15 refractive index of n_o and an extraordinary refractive index of n_e ($n_o \neq n_e$), the birefringent material layer being processed to have a periodical concavo-convex shape having a step height of d in cross section, a homogeneous refractive index transparent material having a refractive
20 index equal to n_o or n_e is filled in at least the concave portions, and the retardation value $|n_e - n_o| \times d$ is $(m + 1/2)$ times (m is zero or a positive integer) the wavelength λ of the incident light.
3. The multi-layer diffraction type polarizer according
25 to Claim 1, wherein the step heights d of the polarizing diffraction gratings are different from each other.
4. The multi-layer diffraction type polarizer according

to Claim 2, wherein the step heights d of the polarizing diffraction gratings are different from each other.

5. A liquid crystal element comprising:

a liquid crystal cell comprising transparent substrates
5 having electrodes and a liquid crystal layer sandwiched
between them, the liquid crystal cell having a
retardation value for a linearly polarized light having a
wavelength of λ incident and transmitting through the
liquid crystal cell, the retardation value changing from
10 R_1 to R_2 ($R_1 > R_2 > 0$) when the voltage applied between the
electrodes is changed from V_1 to V_2 ($V_1 \neq V_2$); and
a phase plate having a retardation value R for a linearly
polarized light having a wavelength of λ , the retardation
value R satisfying a relation $R + R_v = m \times \lambda$ (m : integer) with
15 a retardation value R_v generated by the voltage
satisfying $R_1 \geq R_v \geq R_2$.

6. The liquid crystal element according to Claim 5,
wherein the liquid crystal in the liquid crystal element
is a nematic liquid crystal, and the alignment of the
20 liquid crystal molecules is a parallel alignment in which
the liquid crystal molecules are aligned in parallel in
one direction between the transparent substrates when the
voltage is not applied, the first phase plate satisfies a
relation $R + R_v = 0$, and the fast axis direction of the
25 first phase plate is within an angle of 45° with respect
to the slow axis direction of the liquid crystal layer.

7. The liquid crystal element according to Claim 5,

which further comprises a polarizing diffraction grating comprising a birefringent material at at least one of the light input side and the light output side of the liquid crystal element, wherein the diffraction grating

5 straightly transmits incident light having a first polarization direction without functioning as a polarizer, and diffracts incident light having a second polarization direction perpendicular to the first polarization direction by functioning as a polarizer.

10 8. The liquid crystal element according to Claim 6, which further comprises a polarizing diffraction grating comprising a birefringent material at at least one of the light input side and the light output side of the liquid crystal element, wherein the diffraction grating
15 straightly transmits incident light having a first polarization direction without functioning as a polarizer, and diffracts incident light having a second polarization direction perpendicular to the first polarization direction by functioning as a polarizer.

20 9. A liquid crystal element having a $\lambda/4$ phase plate, comprising:

a liquid crystal cell comprising substrates having electrodes and a liquid crystal layer sandwiched between them, the liquid crystal cell having a retardation value
25 changeable for linearly polarized incident light having a wavelength of λ depending on the magnitude of a voltage applied between the electrodes; and

a $\lambda/4$ phase plate producing a phase-shift corresponding to a retardation value of substantially $\lambda/4$ for the linearly polarized incident light, the $\lambda/4$ phase plate having an organic thin film and the alignment of molecules constituting the organic thin film is in parallel with the plane of the phase plate;

wherein the fast axis direction of the phase plate is at an angle of about 45° to the fast axis direction of the liquid crystal cell.

10 10. The liquid crystal element having a $\lambda/4$ phase plate according to Claim 9, wherein the phase plate comprises a liquid crystal polymer as the organic thin film, and the phase plate and the liquid crystal cell are integrally formed.

15 11. The liquid crystal element having a $\lambda/4$ phase plate according to Claim 10, wherein the phase plate comprises at least two liquid crystal polymer layers, the retardation values of the two liquid crystal polymer layers are different from each other, and the fast axis directions or the slow axis directions of the two liquid crystal polymer layers are different from each other.

20 12. The liquid crystal element having a $\lambda/4$ phase plate according to Claim 11, which comprises the liquid crystal cell, a first liquid crystal polymer layer and a second liquid crystal polymer layer arranged in this order from light input side, wherein with respect to the center wavelength λ of incident light, the retardation value of

the first liquid crystal polymer layer is substantially $\lambda/2$, and the retardation value of the second liquid crystal polymer layer is substantially $\lambda/4$; and with respect to the polarization direction of the incident light, the fast axis direction of the first liquid crystal polymer layer and the fast axis direction of the second liquid crystal polymer layer are about 30 degrees and about -30 degrees respectively, or otherwise, the slow axis direction of the first liquid crystal polymer layer and the slow axis direction of the second liquid crystal polymer layer are about 30 degrees and about -30 degrees respectively.